

Middlesex University Research Repository

An open access repository of

Middlesex University research

<http://eprints.mdx.ac.uk>

Shah, Purav ORCID logoORCID: <https://orcid.org/0000-0002-0113-5690>, Ahmed, M. Z. and Kurihara, Y. (2007) New method for generalised PR target design for perpendicular magnetic recording. In: The Eighth Perpendicular Magnetic Recording Conference (PMRC 2007), Oct 15 - 17, 2007, Tokyo International Forum, Tokyo, Japan. . [Conference or Workshop Item]

This version is available at: <https://eprints.mdx.ac.uk/7764/>

Copyright:

Middlesex University Research Repository makes the University's research available electronically.

Copyright and moral rights to this work are retained by the author and/or other copyright owners unless otherwise stated. The work is supplied on the understanding that any use for commercial gain is strictly forbidden. A copy may be downloaded for personal, non-commercial, research or study without prior permission and without charge.

Works, including theses and research projects, may not be reproduced in any format or medium, or extensive quotations taken from them, or their content changed in any way, without first obtaining permission in writing from the copyright holder(s). They may not be sold or exploited commercially in any format or medium without the prior written permission of the copyright holder(s).

Full bibliographic details must be given when referring to, or quoting from full items including the author's name, the title of the work, publication details where relevant (place, publisher, date), pagination, and for theses or dissertations the awarding institution, the degree type awarded, and the date of the award.

If you believe that any material held in the repository infringes copyright law, please contact the Repository Team at Middlesex University via the following email address:

eprints@mdx.ac.uk

The item will be removed from the repository while any claim is being investigated.

See also repository copyright: re-use policy: <http://eprints.mdx.ac.uk/policies.html#copy>

New Method for Generalised PR Target Design for Perpendicular Magnetic Recording

P. Shah¹, M.Z. Ahmed¹ and Y. Kurihara²

¹ Centre for Research in Information Storage Technology, University of Plymouth, Plymouth PL4 8AA, UK.

² Department of Electronic Control Engineering, Niihama National College of Technology, Niihama, 792-8580, Japan.
Email: {purav.shah,m.ahmed}@plymouth.ac.uk, kurihara@ect.niihama-nct.ac.jp

I. INTRODUCTION

In recent years, perpendicular magnetic recording (PMR) has been the main topic of interest in the industry. Given current estimates, that would suggest an areal density using PMR as great as one terabit per square inch – making possible in two to three years a 3.5-inch disk drive capable of storing an entire terabyte of data [1]. As the areal density is increased, however, the signal processing aspects of magnetic recording becomes more difficult.

The present technique for finding the optimised GPR targets is based on the minimum mean squared error (MMSE) between the equaliser output and the desired output, subject to the monic constraint [2]. In this paper, we present a new method of designing GPR targets for PMR. This method is based on maximising the ratio of minimum squared euclidean distance of the PR target to the noise penalty introduced by the PR filter. The description of the channel model and the new method follows in the next section and the results and comparison follows after that.

II. SIMULATION MODEL

Figure(1(a)) shows the block diagram of the PMR system model used in this paper. The user data, denoted as a_k , is a sequence of input symbols taking values of 0, 1. To simulate the write current, the sequence a_k is mapped to $-1, +1$. The scaling factor of 0.5 is to ensure the transition takes values of $-1, 0, +1$. We approximate the single-transition step response, denoted as $s(t)$, using the hyperbolic tangent function [3][4]:

$$s(t) = A \cdot \tanh \left(\ln(3) \frac{t}{PW_{50}} \right) \quad (1)$$

where A is the saturation level/amplitude from zero to peak(normalised to unity) and PW_{50} is the time taken for $s(t)$ to go from $-A/2$ to $+A/2$. It is assumed that t and PW_{50} are normalised to the symbol period, T . The dibit response $p(t)$ is defined as:

$$p(t) = s(t) - s(t - 1) \quad (2)$$

The readback signal $r(t)$ is the convolution of a_k and $p(t)$ plus some Additive White Gaussian Noise (AWGN):

$$r(t) = \underbrace{\sum_k a_k p(t - kT)}_{b(t)} + n(t) \quad (3)$$

where $n(t)$ is the AWGN with mean of 0 and variance of σ^2 . A Maximum Likelihood Sequence Detector (MLSD) is used to provide the decoder solution which is used for performance evaluation.

III. GPR TARGET SEARCH METHOD

The present technique [2] for achieving optimised GPR target is optimal only if the receiver has noise prediction. If there is no noise prediction, then the equaliser leads to additional noise. This is as shown in figure(1(b)). Considering a PR equaliser with a monic constraint, where $h(0) = 1$, the new technique described in this paper is based on the calculation of ratio of the minimum squared euclidean distance of the PR scheme under this monic constraint to the squared noise penalty introduced by the filter. Consider the N tap coefficients $h(\frac{N-1}{2}), \dots, \dots, h(\frac{N-1}{2})$, where N is an odd integer. The equalised signal y is:

$$\begin{aligned} y &= r(t) * h(t) \\ &= b(t) * h(t) + n(t) * h(t) \\ &= b(t) * h(t) + n(t) + n_f(t) \end{aligned} \quad (4)$$

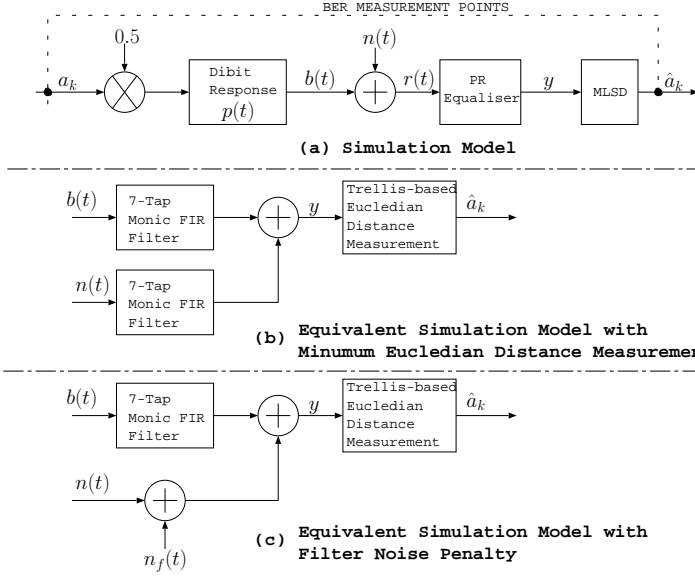


Figure 1: Simulation Block including GPR Target Search

PW_{50}	Target
1.3	[1,4,7,3]
1.4	[1,5,8,4]
1.5	[1,5,8,4]

Figure 2: GPR Target Results

Here, $n_f(t)$ is the noise penalty from the filter. The analysis of the system is shown in Figure 1.

The rule of optimisation is to find the GPR target that maximises the ratio of minimum squared euclidean distance on the trellis over the noise penalty. Thus, the effective design ratio is:

$$\text{Design Ratio} = \frac{\text{Minimum Squared Euclidean Distance}}{\text{Filter Noise Penalty}} \quad (5)$$

where, the filter noise penalty is computed as,

$$\text{Filter Noise Penalty} = \sum_{\forall j, j \neq 0} h(j)^2 \quad (6)$$

The optimised search looks for the PR target that maximises this Design Ratio. Results from this are in Figure 2.

RESULTS AND DISCUSSIONS

The GPR targets obtained using this new method for GPR search are the same with traditional method of GPR search for most PW_{50} . This new method provides consistently equal or better targets for PRML schemes that does not include noise prediction. Future work will focus on investigating the effect of media noise.

REFERENCES

- [1] R. Wood, Y. Hsu, and M. Schultz, "Perpendicular magnetic recording," *Internet Resource*, July 2007. Hitachi GST White Paper.
- [2] P. Kovintavewat, I. Ozgunes, E. Kurtas, J. Barry, and S. McLaughlin, "Generalised partial response targets for perpendicular recording," *IEEE Transactions on Magnetics*, vol. 38, pp. 2340–2342, September 2002.
- [3] Y. Okamoto, H. Osawa, H. Saito, H. Muraoka, and Y. Nakamura, "Performance of prml systems in perpendicular magnetic recording channel with jitter-like noise," *Journal of Magnetism and Magnetic Materials*, vol. 235, no. 43, pp. 251–264, 2001.
- [4] H. Sawaguchi, Y. Nishida, H. Takano, and H. Aoi, "Performance analysis of modified prml channels for perpendicular recording systems," *Journal of Magnetism and Magnetic Materials*, vol. 235, pp. 265–272, 2001.